Comparison of Coronary Artery Calcium Scores Between Patients With Psoriasis and Type 2 Diabetes

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IMPORTANCE Psoriasis is associated with an increased risk of cardiovascular diseases. Subclinical atherosclerosis in patients with psoriasis has not been compared with other conditions associated with increased cardiovascular risk and more rigorous cardiovascular disease screening, such as type 2 diabetes.

OBJECTIVE To assess the burden of asymptomatic coronary atherosclerosis measured by coronary artery calcium score in patients with moderate to severe psoriasis compared with patients with type 2 diabetes and healthy controls.

DESIGN, SETTING, AND PARTICIPANTS Three single-center, cross-sectional studies were performed in patients recruited from specialty outpatient clinics with moderate to severe psoriasis without type 2 diabetes (recruited from November 1, 2013, through April 31, 2015), patients with type 2 diabetes without psoriasis or other inflammatory diseases (recruited from July 1, 2009, through June 20, 2011), and age- and sex-matched healthy controls without psoriasis, type 2 diabetes, or other inflammatory diseases (recruited from July 1, 2009, through June 20, 2011).

EXPOSURES Psoriasis, type 2 diabetes, and healthy control effect on coronary artery calcium score.

MAIN OUTCOMES AND MEASURES Coronary artery calcium measured by Agatston score.

RESULTS A total of 387 individuals participated in the study. Mean (SD) age was 51 (7.7), 52 (8.0), and 52 (8.0) years in the psoriasis, type 2 diabetes, and healthy control cohorts, respectively. There were 64 men (49.6%) in each group, and most patients were white (119 [92.2%], 123 [95.3%], and 128 [99.2%] in the psoriasis, type 2 diabetes, and healthy control cohorts, respectively). Patients with psoriasis had low cardiovascular risk measured by the Framingham Risk Score but had a high prevalence of cardiovascular and cardiometabolic risk factors, similar to patients with type 2 diabetes. In a fully adjusted model, psoriasis was associated with coronary artery calcium (Tobit regression ratio, 0.89; P < .001) similar to the association in type 2 diabetes (Tobit regression ratio, 0.79; P = .04). Likelihood ratio testing revealed incremental value for psoriasis in a fully adjusted model (χ² = 4.48, P = .03) in predicting coronary artery calcium. Psoriasis was independently associated with the presence of any coronary artery calcium (odds ratio, 2.35; 95% CI, 1.12-4.94) in fully adjusted models, whereas the association of coronary artery calcium with type 2 diabetes was no longer significant after adding body mass index to the model (odds ratio, 2.18; 95% CI, 0.75-6.35).

CONCLUSIONS AND RELEVANCE Patients with psoriasis have increased coronary artery calcium by mean total Agatston scores, similar to that of patients with type 2 diabetes, suggesting that patients with psoriasis harbor higher rates of subclinical atherosclerosis beyond adjustment for body mass index. Major educational efforts for patients and physicians should be undertaken to reduce the burden of cardiovascular disease in patients with psoriasis.
Psoriasis is an immune-mediated genetic disease associated with systemic inflammation that affects approximately 2% of North American and European populations. Prevalence varies based on racial and geographic differences. Approximately 20% to 25% of patients have moderate to severe disease, requiring systemic therapy. Up to one-third of patients with psoriasis develop psoriatic arthritis. Psoriasis is strongly linked with several behavioral and medical comorbidities, including the metabolic syndrome and cardiovascular disease.

Psoriasis appears to be an independent risk factor for coronary artery disease, myocardial infarction, cerebrovascular disease, stroke, peripheral vascular disease, and cardiovascular mortality. Patients with psoriasis have an excess risk of cardiovascular mortality, which is the leading cause of mortality in this group, a 4- to 5-year younger mean age at death compared with those without psoriasis, and an increased major adverse cardiovascular events risk, particularly those who have severe psoriatic disease or have not been prescribed disease-modifying antirheumatic drugs. Furthermore, the presence of severe psoriasis confers an additional 6.2% absolute excess risk of 10-year major adverse cardiovascular events, even after adjusting for age, sex, type 2 diabetes, hypertension, tobacco use, and hyperlipidemia. Framingham Risk Scores (FRSs) underestimated cardiovascular risk in 73% of low-risk and 53% of high-risk patients with psoriasis, who were reclassified to higher-risk categories. Despite these substantial data, patients with psoriasis are not actively educated, counseled, or screened for cardiovascular disease because data have been limited by the retrospective nature of population-based studies and the limited power of prospective studies using novel imaging methods.

Surrogate outcome measures quantifying cardiovascular risk are important. Coronary artery calcium (CAC) assessment has become widely accepted as a true measure of the total burden of atherosclerosis and the cornerstone for screening the risk of future cardiac events and improving cardiovascular risk stratification beyond traditional risk factors, especially in higher-risk groups. Three studies found an association between moderate to severe psoriasis and increased CAC, yet cardiovascular risk stratification for patients with psoriasis remains the same as the general population despite increasing evidence to support this important excess in cardiovascular risk.

Type 2 diabetes mellitus provides an important model of an established, high-risk disease associated with increased cardiovascular risk for comparison. Patients with psoriasis have atherogenic lipoprotein and adipokine profiles similar to those in patients with type 2 diabetes. Furthermore, CAC assessment is superior to traditional cardiovascular risk factors for predicting silent myocardial ischemia and short-term outcomes, myocardial infarction and cardiac death, and cardiovascular events (including stroke) in asymptomatic type 2 diabetes. As a result, the American College of Cardiology/American Heart Association guidelines now recommend computed tomography for CAC assessment to improve cardiovascular risk stratification in asymptomatic patients 40 years or older with type 2 diabetes. The objective of this study was to compare CAC scores in patients with psoriasis with CAC scores in patients with type 2 diabetes based on the assumption that comparable increases in CAC scores would support the need for heightened awareness and appropriate screening for cardiovascular disease in patients with psoriasis.

**Key Points**

**Question** How does the burden of asymptomatic coronary atherosclerosis measured by coronary artery calcium score in patients with moderate to severe psoriasis compare with patients with type 2 diabetes and healthy controls?

**Findings** In this analysis of data from 3 cross-sectional studies, the prevalence of moderate to severe coronary calcium was similar between patients with psoriasis and those with type 2 diabetes and approximately 5 times greater than healthy controls. Coronary calcium in patients with moderate to severe psoriasis was similarly associated with known cardiovascular and cardiometabolic risk factors when compared with patients with type 2 diabetes, and the presence of moderate to severe psoriasis was a significantly stronger predictor of coronary calcium than type 2 diabetes, independent of the effect of known cardiovascular and cardiometabolic risk factors.

**Meaning** These findings support screening for cardiovascular risk factors systematically in patients with moderate to severe psoriasis and type 2 diabetes.

**Methods**

Our study population was composed of unrelated individuals recruited from a specialty psoriasis clinic at the Baylor University Medical Center (BUMC), the Penn Diabetes Heart Study (PDHS), and the Philadelphia Area Metabolic Syndrome Network (PAMSyN). The cohorts represent patients with moderate to severe psoriasis without type 2 diabetes (BUMC), type 2 diabetes without psoriasis or other inflammatory diseases (PDHS), and age- and sex-matched healthy controls without psoriasis, type 2 diabetes, or other inflammatory diseases (PAMSyN). Patients in all cohorts had no history of coronary heart disease. Patients with psoriasis were consecutively screened for potential study inclusion from November 1, 2013, through April 31, 2015. Patients with type 2 diabetes without psoriasis or other inflammatory diseases were recruited from July 1, 2009, through June 20, 2011, and age- and sex-matched healthy controls without psoriasis, type 2 diabetes, or other inflammatory diseases were recruited from July 1, 2009, through June 20, 2011. Treated and untreated patients with psoriasis were included and required a diagnosis of moderate to severe psoriasis defined as having 1 of the following 4 criteria: (1) body surface area involvement greater than 10%, (2) Psoriasis Area and Severity Index score greater than 10, (3) Dermatology Life Quality Index score greater than 10, or (4) treatment with oral systemic and/or biological therapy for at least 6 months. Patients with a history of cardiovascular disease or symptoms, type 2 diabetes (defined as self-reported history, current use of medications, or fasting blood glucose level >126 mg/dL [to convert to millimoles per liter, multiply...
Coronary Artery Calcium Scores in Psoriasis and Type 2 Diabetes

Results
Characteristics of Study Groups
Table 1 summarizes patients’ demographic and clinical characteristics. A total of 387 individuals participated in the study. Mean (SD) age was 51 (7.7), 52 (8.0), and 52 (8.0) years in the psoriasis, type 2 diabetes, and healthy control cohorts, respectively. There were 64 men (49.6%) in each group, and most patients were white (119 [92.2%], 123 [95.3%], and 128 [99.2%] in the psoriasis, type 2 diabetes, and healthy control cohorts, respectively). A significantly high prevalence of cardiovascular and cardiometabolic risk factors was noted in the psoriasis and type 2 diabetes cohorts, with the type 2 diabetes cohort having the highest prevalence of hypertension (49 [38.0%] in the psoriasis cohort vs 71 [55.0%] in the type 2 diabetes cohort, \( P < .006 \)) and waist circumference (99.75 [16.8] cm in the psoriasis cohort vs 108.0 [15.8] cm in the type 2 diabetes cohort, \( P = .001 \)). Dyslipidemia was most prevalent in the psoriasis cohort (107 [82.9%] in the psoriasis cohort vs 81 [62.8%] in the type 2 diabetes cohort, \( P < .001 \)). However, the type 2 diabetes group had significantly higher triglyceride levels (median, 100 mg/dL [interquartile range, 77-138 mg/dL]) for the psoriasis cohort vs 132 mg/dL [interquartile range, 92-174 mg/dL]) for the type 2 diabetes cohort; \( P = .002 \) and lower HDL-C levels (57.7 [19.2] mg/dL for the psoriasis cohort vs 47.1 [11.4] mg/dL for the type 2 diabetes cohort, \( P < .001 \)). The control group had greater total cholesterol (175.6 [37.2] mg/dL in the type 2 diabetes cohort vs 204.6 [36.6] in the control cohort, \( P < .001 \)) and LDL-C levels (99.1 [28.7] mg/dL in the type 2 diabetes cohort vs 122.5 [32.2] mg/dL in the control cohort, \( P < .001 \)). The psoriasis and type 2 diabetes cohorts had a similar distribution of CAC in higher tertiles (CAC score >100 and CAC score >400, respectively) compared with the healthy control cohort.

Characteristics of the Psoriasis Cohort
Table 2 summarizes the psoriasis cohort characteristics stratified by the presence of coronary calcium (CAC score >0 and CAC score >0. Patients with psoriasis (\( n = 129 \)) had median disease duration of 11 years. The mean age of psoriasis onset was 27.8 years, with a later onset in patients with CAC scores...
greater than 0 (25 vs 31 years, \(P = .02\)). A total of 120 patients (93.0%) had plaque-type psoriasis, and a significantly higher percentage of patients with plaque-type psoriasis had no evidence of CAC (74 [98.7%] vs 46 [85.2%] in the CAC score of 0 vs CAC score >1 groups, \(P = .003\)). A total of 66 patients (51.2%) had nail involvement, and 26 (20.2%) had nonpustular involvement of their palms and/or soles. A total of 96 patients (74.4%) were undergoing systemic therapy for a median of 3 years, with 96 patients (74.4%) receiving biological therapy. Psoriasis disease activity was generally well controlled (median Psoriasis Area and Severity Index score, 1.2; median body surface area, 4%), with 100 patients (77.5%) either clear (score of 0) or having minimal (score of 1) disease based on the Physician Global Assessment. Forty-four patients (34.1%) had concomitant psoriatic arthritis. No significant differences were observed in clinical severity scores or treatment status between the 2 groups.

### Table 1. Demographic and Clinical Characteristics of the Study Populations

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Psoriasis Cohort (n = 129)</th>
<th>Type 2 Diabetes Cohort (n = 129)</th>
<th>Healthy Controls (n = 129)</th>
<th>(P) Valueb</th>
<th>Psoriasis Cohort vs Type 2 Diabetes Cohort</th>
<th>Psoriasis Cohort vs Healthy Controls</th>
<th>Type 2 Diabetes Cohort vs Healthy Controls</th>
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</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>51 (7.7)</td>
<td>52 (8.0)</td>
<td>52 (8.0)</td>
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<td>NA</td>
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<tr>
<td>Male sex</td>
<td>64 (49.6)</td>
<td>64 (49.6)</td>
<td>64 (49.8)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>Race/ethnicity</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>White</td>
<td>119 (92.2)</td>
<td>123 (95.3)</td>
<td>128 (99.2)</td>
<td>.61</td>
<td>.05</td>
<td>.14</td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>5 (3.9)</td>
<td>2 (1.6)</td>
<td>0</td>
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<tr>
<td>Hispanic</td>
<td>4 (3.1)</td>
<td>4 (3.1)</td>
<td>1 (0.8)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1 (0.8)</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>49 (38.0)</td>
<td>71 (55.0)</td>
<td>47 (36.4)</td>
<td>.006</td>
<td>.80</td>
<td>.003</td>
<td>.001</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>107 (82.9)</td>
<td>81 (62.8)</td>
<td>50 (38.8)</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Metabolic syndrome</td>
<td>49 (38.0)</td>
<td>96 (74.4)</td>
<td>28 (21.7)</td>
<td>&lt;.001</td>
<td>.006</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
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<td>Current smoking</td>
<td>12 (9.3)</td>
<td>16 (12.4)</td>
<td>23 (17.8)</td>
<td>.42</td>
<td>.04</td>
<td>.22</td>
<td></td>
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<tr>
<td>Regular exercise</td>
<td>60 (46.5)</td>
<td>74 (57.4)</td>
<td>71 (55.0)</td>
<td>.08</td>
<td>.1</td>
<td>.93</td>
<td></td>
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<tr>
<td>Body mass index</td>
<td>28.6 (6.3)</td>
<td>33.1 (6.4)</td>
<td>30.0 (4.5)</td>
<td>&lt;.001</td>
<td>.04</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Waist circumference, cm</td>
<td>99.75 (16.8)</td>
<td>108.0 (15.8)</td>
<td>99.6 (14.0)</td>
<td>.001</td>
<td>.92</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>BP, mm Hg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic</td>
<td>129.6 (18.1)</td>
<td>125.2 (14.3)</td>
<td>125.6 (16.0)</td>
<td>.03</td>
<td>.05</td>
<td>.83</td>
<td></td>
</tr>
<tr>
<td>Diastolic</td>
<td>79.83 (12.2)</td>
<td>75.02 (8.9)</td>
<td>75.67 (9.2)</td>
<td>.004</td>
<td>.002</td>
<td>.56</td>
<td></td>
</tr>
<tr>
<td>FRS 10-y risk, median (IQR)</td>
<td>9 (6-12)</td>
<td>8 (5-13)</td>
<td>5 (3-8)</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>Lipid and glucose profile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cholesterol, mean (SD), mg/dL</td>
<td>188.3 (34.7)</td>
<td>175.6 (37.2)</td>
<td>204.6 (36.6)</td>
<td>.005</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>LDL-C, mean (SD), mg/dL</td>
<td>108.2 (28.7)</td>
<td>99.09 (28.7)</td>
<td>122.5 (32.2)</td>
<td>.01</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>HDL-C, mean (SD), mg/dL</td>
<td>57.70 (19.2)</td>
<td>47.11 (11.4)</td>
<td>55.51 (14.3)</td>
<td>&lt;.001</td>
<td>.31</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>Triglycerides, median (IQR), mg/dL</td>
<td>100 (77-138)</td>
<td>132 (92-174)</td>
<td>108 (88-151)</td>
<td>&lt;.001</td>
<td>.03</td>
<td>.04</td>
<td></td>
</tr>
<tr>
<td>VLDL-C, median (IQR)</td>
<td>22 (13-27)</td>
<td>27 (19-38)</td>
<td>24 (17-32)</td>
<td>.09</td>
<td>.37</td>
<td>.03</td>
<td></td>
</tr>
<tr>
<td>Glucose, median (IQR), mg/dL</td>
<td>92 (86-99)</td>
<td>119 (100-146)</td>
<td>69 (62-74)</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>CAC score, median (IQR)</td>
<td>0 (0-50)</td>
<td>1 (0-76)</td>
<td>0 (0-6)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Abbreviations: BP, blood pressure; CAC, coronary artery calcium; FRS, Framingham Risk Score; HDL-C, high-density lipoprotein cholesterol; IQR, interquartile range; LDL-C, low-density lipoprotein cholesterol; NA, not applicable; VLDL-C, very low-density lipoprotein cholesterol. SI conversion factors: To convert total cholesterol, LDL-C, and HDL-C to millimoles per liter, multiply by 0.0259; triglycerides to millimoles per liter, multiply by 0.0113; glucose to millimoles per liter, multiply by 0.0555.

*Data are presented as number (percentage) of patients unless otherwise indicated.

b \(P\) values were derived from a simple unpaired, 2-tailed t test for parametric variables and from the Mann-Whitney test for nonparametric variables. The \(\chi^2\) test was used for categorical variables. \(P < .05\) is considered statistically significant.

c Calculated as weight in kilograms divided by height in meters squared.

### Association of Psoriasis and Traditional Cardiovascular Risk Factors With CAC

We performed a stratified analysis based on prevalence of traditional cardiovascular risk factors in patients with psoriasis (Figure). Presence of any traditional risk factor in addition to psoriasis was associated with increased CAC compared with...
psoriasis alone. Furthermore, a higher number of risk factors was associated with higher median CAC assessed by mean Agatston score (P for all between-group comparisons <.01). The overall trend of increasing CAC was strongly significant (P < .001). Similar findings were observed in type 2 diabetes (Figure, B).
Association of CAC in Psoriasis With Cardiovascular and Cardiometabolic Risk Factors

In unadjusted Tobit regression analysis of CAC compared with variables of interest, all 3 groups had significant correlations between CAC and age, male sex, and FRS 10-year risk, as would be expected (Table 3). The CAC in the psoriasis cohort revealed stronger correlations with cardiovascular and cardiometabolic risk factors, including hypertension (Tobit regression ratio [TRR], 1.73; 95% CI, 0.96-2.51; P < .001), metabolic syndrome (TRR, 1.02; 95% CI, 0.20-1.83; P = .02), waist circumference (TRR, 4.74; 95% CI, 2.15-6.93; P < .001), systolic (TRR, 4.72; 95% CI, 1.76-7.69; P = .002) and diastolic (TRR, 3.66; 95% CI, 0.88-6.42; P = .01) blood pressures, FRS 10-year risk (TRR, 1.78; 95% CI, 1.00-2.55; P < .001), HDL-C level (TRR, 2.52; 95% CI, 1.56-3.58; P < .001), and triglycerides (TRR, 3.61; 95% CI, 1.75-5.46; P < .001) with psoriasis, patients with type 2 diabetes, and healthy controls. In the psoriasis group, the CAC was associated with the presence of any CAC after adjusting for age, sex, and cardiovascular risk factors, metabolic syndrome, and medication use (aspirin, angiotensin-converting enzyme inhibitors, and statins). Psoriasis was associated with CAC and type 2 diabetes (OR, 2.55; 95% CI, 1.12-5.39; P = .02) and metabolic syndrome (OR, 1.34; 95% CI, 0.75-2.35; P = .30) with psoriasis, patients with type 2 diabetes, and healthy controls.

Association of Psoriasis With CAC in Models Adjusted for Cardiometabolic Risk Factors

Hierarchical Tobit regression analysis (Table 4) was performed to define the association between the presence of disease (psoriasis or type 2 diabetes) and CAC after adjusting for groups of confounding variables. In unadjusted analysis, type 2 diabetes (TRR, 1.12; 95% CI, 0.57-1.67; P < .001) had a stronger association with CAC than psoriasis (TRR, 0.73; 95% CI, 0.18-1.29; P = .01). However, in the final model, which was fully adjusted for age, sex, cardiovascular risk factors (LDL-C, HDL-C, triglycerides, and fasting blood glucose levels, systolic blood pressure, and tobacco use), cardiometabolic risk factors (BMI and metabolic syndrome), and medication use (aspirin, angiotensin-converting enzyme inhibitors, and statins), psoriasis was associated with CAC (TRR, 0.89; 95% CI, 0.35-1.44; P < .001) and metabolic syndrome (TRR, 0.89; 95% CI, 0.35-1.44; P = .04).

Logistic multivariable regression models (Table 5) were constructed using the same models as in the Tobit regression analysis, with CAC score greater than 0 as the outcome. Psoriasis was associated with the presence of any CAC after adjusting for age, sex, and cardiovascular risk factors, metabolic risk factors, and medication use (OR, 2.35; 95% CI, 1.12-4.94), which attenuated when BMI was added to the model (OR, 2.18; 95% CI, 0.75-6.35) in type 2 diabetes. Furthermore, when we added use of systemic or biological therapy to the models, the TRR and OR increased; however, these analyses were exploratory.

Discussion

We report 4 salient findings from our comparison of patients with psoriasis, patients with type 2 diabetes, and healthy controls: (1) the CAC in the psoriasis cohort revealed stronger correlations with cardiovascular and cardiometabolic risk factors than the type 2 diabetes (TRR, 4.94; which attenuated when BMI was added to the model (OR, 2.18; 95% CI, 0.75-6.35) in type 2 diabetes. Furthermore, when we added use of systemic or biological therapy to the models, the TRR and OR increased; however, these analyses were exploratory.

Association of CAC in Psoriasis With Cardiovascular and Cardiometabolic Risk Factors

In unadjusted Tobit regression analysis of CAC compared with variables of interest, all 3 groups had significant correlations between CAC and age, male sex, and FRS 10-year risk, as would be expected (Table 3). The CAC in the psoriasis cohort revealed stronger correlations with cardiovascular and cardiometabolic risk factors, including hypertension (Tobit regression ratio [TRR], 1.73; 95% CI, 0.96-2.51; P < .001), metabolic syndrome (TRR, 1.02; 95% CI, 0.20-1.83; P = .02), waist circumference (TRR, 4.74; 95% CI, 2.15-6.93; P < .001), systolic (TRR, 4.72; 95% CI, 1.76-7.69; P = .002) and diastolic (TRR, 3.66; 95% CI, 0.88-6.42; P = .01) blood pressures, FRS 10-year risk (TRR, 1.78; 95% CI, 1.00-2.55; P < .001), HDL-C level (TRR, 2.52; 95% CI, 1.56-3.58; P < .001), and triglycerides (TRR, 3.61; 95% CI, 1.75-5.46; P < .001) when compared with the age- and sex-matched type 2 diabetes group. In the type 2 diabetes cohort, CAC scores more strongly correlated with current smoking (TRR, 1.02; 95% CI, 0.01-2.04; P = .04), regular exercise (TRR, 0.73; 95% CI, 0.01-1.45; P = .04), triglycerides level (TRR, 0.93; 95% CI, 0.18-1.67; P = .02), and very low-density lipoprotein cholesterol level (TRR, 0.70; 95% CI, 0.05-1.34; P = .03). Spearman correlation analysis also revealed similar associations as univariate regression analysis (Table 1 in the Supplement).

Logistic multivariable regression models (Table 5) were constructed using the same models as in the Tobit regression analysis, with CAC score greater than 0 as the outcome. Psoriasis was associated with the presence of any CAC after adjusting for age, sex, and cardiovascular risk factors, metabolic risk factors, and medication use (OR, 2.35; 95% CI, 1.12-4.94), which attenuated when BMI was added to the model (OR, 2.18; 95% CI, 0.75-6.35) in type 2 diabetes. Furthermore, when we added use of systemic or biological therapy to the models, the TRR and OR increased; however, these analyses were exploratory.

Discussion

We report 4 salient findings from our comparison of patients with psoriasis, patients with type 2 diabetes, and healthy controls.
Abbreviation: NA, not applicable.

* Model 1 was adjusted for age and sex; model 2 was adjusted for age, sex, and cardiovascular risk factors (low-density lipoprotein cholesterol level, high-density lipoprotein cholesterol level, triglycerides level, systolic blood pressure, fasting blood glucose level, and current tobacco use); model 3 was adjusted for age, sex, and cardiovascular and cardiometabolic risk factors (body mass index and metabolic syndrome); model 4 was adjusted for demographics, cardiovascular and cardiometabolic risk factors, and medication use (aspirin, angiotensin-converting enzyme inhibitors, and statins); and model 5 was adjusted for demographics, cardiovascular and cardiometabolic risk factors, medication use, and psoriasis and rheumatologic treatment (methotrexate, any systemic, and any biological treatment). All variables were log transformed before use in the Tobit regression models. 

b \( P < .05 \) is considered statistically significant.

Abbreviation: NA, not applicable.

* Model 1 was adjusted for age and sex; model 2 was adjusted for age, sex, and cardiovascular risk factors (low-density lipoprotein cholesterol level, high-density lipoprotein cholesterol level, triglycerides level, systolic blood pressure, fasting blood glucose level, and current tobacco use); model 3 was adjusted for age, sex, and cardiovascular and cardiometabolic risk factors (body mass index and metabolic syndrome); model 4 was adjusted for demographics, cardiovascular and cardiometabolic risk factors, and medication use (aspirin, angiotensin-converting enzyme inhibitors, and statins); and model 5 was adjusted for demographics, cardiovascular and cardiometabolic risk factors, medication use, and psoriasis and rheumatologic treatment (methotrexate, any systemic, and any biological treatment). All variables were log transformed before use in the Tobit regression models.

b \( P < .05 \) is considered statistically significant.
plaque but may not always account for the noncalcified plaque burden (ie, the type that is vulnerable for rupture). Nonetheless, studies have found that CAC can reliably predict future adverse cardiovascular events, correlates well with cardiac computed tomography angiography findings of significant angiographic stenosis,\(^5\) is cost-effective,\(^6\) and provides an additive benefit to existing cardiovascular risk assessment tools.\(^7\)

The beneficial role of CAC in cardiovascular risk assessment of type 2 diabetes has been well established.\(^25\) However, CAC assessment in psoriasis has only been performed in a small number of case-control studies\(^18-20,46,49\) (eTable 2 in the Supplement). Similar to our results, most of these studies report an increased CAC burden in patients with psoriasis when compared with controls. Although a previous study\(^40\) found a lower risk for cardiovascular events in patients with psoriasis treated with anti–tumor necrosis factor therapy, no study to date has investigated the longitudinal effect of systemic therapy on CAC. In the present study, we found that adjustment for any systemic and biological therapy in multivariable models increased the regression ratio and OR by approximately 50%, thereby suggesting that these treatments may in fact have an association with lower CAC in patients with psoriasis. Ongoing studies\(^51-53\) in psoriasis are investigating the effect of intensive drug treatment on cardiovascular disease (clinicaltrials.gov, NCT01553058, NCT02187172, and NCT01866592). These studies will elucidate the effect of biological treatment on subclinical vascular diseases.

In a landmark study, Gelfand et al\(^5\) found a significantly greater strength in CAC assessment than type 2 diabetes, independent of the effect of known cardiovascular and cardiometabolic risk factors. The attenuation of the association between type 2 diabetes and CAC when adjusted for BMI was not observed in psoriasis, suggesting that CAC may be mediated, in part, by adiposity in type 2 diabetes.

We acknowledge certain limitations relating to our study design. The cross-sectional study design and lack of biological data limit our ability to establish a cause-effect relationship between psoriasis and atherosclerosis. Variations among different ethnic groups could not be established given that most of our study patients were white, which is the major demographic group affected with psoriasis in North America and Europe. Of note, almost all patients with psoriasis controlled their disease well with systemic or biological therapy for approximately 3 years before recruitment. This level of disease control likely underestimates the burden of subclinical atherosclerosis in our cohort. In addition, high-sensitivity C-reactive protein values were not obtained for our cohort of patients with psoriasis. As such, we were unable to adjust for this variable as a crude marker of inflammation in our models. Furthermore, a previous study by Staniak et al\(^40\) found a dose-response relationship between psoriatic skin severity and severe coronary calcium disease (CAC score >400). However, our study failed to find this relationship, likely because of the well-controlled nature of cutaneous disease plus the inclusion of previously treated patients in our study when compared with the cohort of patients with psoriasis.

**Conclusions**

Psoriasis increases CAC scores to the extent of what is observed in type 2 diabetes, independent of the effect of cardiovascular and cardiometabolic risk factors. Psoriasis and type 2 diabetes share similar cardiovascular risk profiles, which may predispose patients to developing coronary atherosclerosis at a relatively young age. These findings warrant early cardiovascular risk assessment and aggressive risk factor modification in those with moderate to severe psoriasis. In addition, CAC assessment may be considered in patients with psoriasis who have 2 or more traditional cardiovascular risk factors given the high prevalence of CAC observed in this study.
as an adviser and/or speaker for Abbvie, Aqua, Lilly, Medimetrix, Novartis, Regeneron-Sanofi, and UCB, receiving honoraria or fees for all. Dr. Meerten reported serving as a consultant or investigator for Abbott Laboratories, receiving honoraria: serving on advisory boards or as a speaker for Abbott Laboratories, AbbVie, Amgen, Astellas Pharma US Inc, Centocor Ortho Biotech Inc, Galdemera Laboratories LP, Pfizer Inc, and Warner Chilcott, receiving honoraria or fees, and reported pending grants from Amgen, Celgene Corporation, Centocor Ortho Biotech Inc, and Pfizer Inc. Dr. Mehta reported being a full-time US government employee. No other disclosures were reported.

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**REFERENCES**


In 1873, Raynaud was elected to the Académie of Medicine.1 Among his many other accomplishments, Raynaud's contributions did not end with his report of this syndrome. A year after receiving his doctoral degree, Raynaud submitted a postdoctoral thesis of 2 notable publications on the history of medicine, the “Asclepiades of Bithynia, doctor and philosopher” and “Medicine in Molière’s time.”1 He was also a prolific writer, and his book Sur la salive d’un enfant mort de la rage was published after a research collaboration with Louis Pasteur and Odilon Marc Lannelongue. In addition, Raynaud was admired and respected as a superb teacher and lecturer throughout the universities and hospitals in Paris. In 1879, he was elected to the Academy of Medicine.1

Despite his numerous achievements, Raynaud was unable to achieve his goal of becoming a chair of medical history in Paris. Cardiac disease plagued Raynaud for several years, and he died in 1881 from an acute myocardial infarction.

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